experiments was undertaken, by a commission appointed by the Lighthouse Board of the United States, to determine the relative powers of various fog signals which were submitted to the notice of the Board. In 1872, a Committee of the Trinity House, with the object of ascertaining the actual efficiency of various fog signals then in operation on the North American continent, visited the United States and Canada, where they found in service, Daboll's trumpets, steam whistles, and siren apparatus, sounded by steam and compressed air; these latter apparatus were devised by Mr. Felix Brown, of Progress Works, New York; and from the report of the Trinity House Committee, it does not appear that they were greatly impressed with this instrument, but probably they had not an opportunity of testing its real merits as compared with other signals. The late Prof. Henry, of the United States Lighthouse Board, entertained a very high opinion of the siren; and on his advice, and the urgent recommendation of Prof. Tyndall, one of these instruments was sent to England, and included in the fog signal experiments at the South Foreland in 1873–74. This investigation was carried out by the Trinity House, with the view of obtaining definite knowledge as to the relative merits of various sound-producing instruments then in use, and also of ascertaining how the propagation of sound is affected by meteorological phenomena. Prof. Tyndall, as scientific adviser of the Trinity House, conducted the investigation, aided by a Committee of the Trinity House, and their engineer. These experiments were extended over a lengthened period, in all conditions of weather, and the well-known scientific and practical results obtained, together with the ascertained relative merits of sound-producing instruments for the service of the mariner, have proved to be of the highest scientific interest and practical importance. The investigation at the South Foreland was followed up by the Trinity House with further explosive fog signal experiments, in which they were assisted by the authorities at Woolwich Arsenal with guns of various forms, weight of charges, and descriptions of gunpowder. The powders tested were (1) fine grain, (2) larger grain, (3) rifle large grain, and (4) pebble. The result placed the sound-producing powers of these powders exactly in the order above stated; the fine grain, or most rapidly burning powder, gave indisputably the loudest sound, while the report of the slowly burning pebble powder was weakest of all. Here again the greater value of increased rapidity of combustion in producing sound was demonstrated. It was found that charges of gun-cotton yielded reports louder at all ranges than equal charges of the best gunpowder; and further experiments proved that the explosion of half a pound of gun-cotton gave a sound equal in intensity to that produced by three pounds of the best gunpowder. These investigations led the Trinity House to adopt gun-cotton for fog signals at isolated stations on rocks and shoals, as already described, where, from want of space, nothing better than a ball, or gong, it had hitherto been possible to apply. Of all the sound signals now employed for the warning and guidance of mariners during fog, viz. bells, gongs, guns, whistles, reed trumpets, sirens, and sounds produced by the explosion of gun-cotton, the blasts of the siren and explosions of gun-cotton have been found to be the most efficient for coast fog signals; therefore these signals have received the greatest care and attention in their development. The siren doubtless ranks first for stations wherever it can be applied, chiefly on account of its economy in maintenance, and the facility it affords for giving prolonged blasts of any desired intensity or pitch, and thus providing any number of trustworthy distinctive characters that may be required to insure individuality in the signal. Sirens are now employed at many floating and shore stations of the Trinity House; and one, recently installed at Saint Catharine's Lighthouse, Isle of Wight, of the automatic Holmes type, of which we have here a model, absorbs during its blasts not less than 600 horse-power. The audibility of the blasts of this instrument may be considered to be trustworthy at a range of two miles under all conditions of foggy atmosphere, on the sea surface, over which it is intended to be sounded. It is very desirable that for many landfall stations a greater trustworthy range be provided for the mariner, but this can only be afforded by such increased power as would be required for a more powerful electric light installation, to serve the mariner in other gradations of thick atmosphere. A very important improvement and economy has lately been effected in the sirens of the Trinity House, by rendering them always instantaneously available for sounding at their maximum power. This is accomplished by the storage of a sufficient quantity of compressed air, at a pressure considerably above that required for sounding, to work the siren during the time required for raising steam and starting the engine. The signal is thus always in readiness for immediate action day or night, with an expenditure of fuel only incurred during fog, which fortunately on the coast of this country does not exceed an average of 440 hours per annum. The experience yet gained with the most powerful fog signals now in use, although these apparatus far exceed in efficiency for the service of the mariner in fog any light that science can provide, is not yet so satisfactory as we could desire. The best signal is, as I have already stated, occasionally not heard, under certain atmospheric conditions, beyond two miles; while under other conditions, not apparent to the mariner, the signal is distinctly audible at ten miles; therefore there is much to be desired in the development of the means of propagating sound waves, and in rendering them audible to the mariner. In conclusion I would venture to state that, with the best light and sound signals that can be provided, there are conditions of the atmosphere in which the mariner will earnestly look and listen in vain for the desired light or sound signal, and he must still, under such circumstances, exercise caution in availing himself of their guidance, and never neglect the assistance always at hand of his old trusty friend the lead.

PRELIMINARY REPORT OF THE NEWALL TELESCOPE SYNDICATE.[1]

AT the end of the Lent Term the Syndicate met for the first time and drew up a Report to the Council of the Senate, recommending that a Committee of experts should go to Gateshead to view Mr. Newall's telescope and report on its condition and capabilities. A letter of acknowledgment was also sent to Mr. Newall thanking him for his generous offer.

In consequence of their recommendation, Mr. Christie, Astronomer Royal, Mr. Common, F.R.S., and Mr. Graham, First Assistant at our Observatory, went to Gateshead and made a thorough examination of the telescope and of its accessories. They reported to the Syndicate as follows:—

Report on Mr. Newall's 25-inch Refractor.

We the undersigned, being the Committee appointed by the Newall Telescope Syndicate to inquire into and report on the condition and capabilities of the above instrument, beg to submit the following report as the result of an examination made on March 28 and 29. For convenience of reference we have divided the report under three heads:—

1. On the present condition of the telescope and dome.
2. On the necessary work to be done in removing and re-erecting, to put the whole in an efficient state.
3. The capabilities of the instrument when re-erected.

I. On the evening of March 28, the sky being overcast, the quality of the object-glass was tested by artificial stars, formed by the light of a lamp shining through holes in a metal screen, placed at a distance of about 1500 yards. The result of those tests, which it is unnecessary to specify more fully, was sufficient to enable the Committee to come to the conclusion that the object-glass is a remarkably fine one, entirely free from any defect. On the conclusion of those tests about midnight, and as the Committee were about to leave, the sky cleared to a slight extent, and at intervals the telescope was turned upon some stars and upon Saturn. Owing to the state of the atmosphere, the definition was very variable, but the Committee saw enough to confirm them in the opinion they had already formed as to the excellent quality of the object-glass. During these examinations and tests the mounting showed itself to be extremely steady and quite free from vibration. On the morning of the 29th the Committee again met at Ferndene to complete the examination of the instrument and dome by daylight. The telescope is no doubt so well known that it is not necessary to state further than that it is a first-class instrument, mounted on the plan of the elder Cooke, and that it is fully provided with all the necessary appliances to make it an extremely convenient and easily managed instrument.

The condition is such that the necessary cleaning, painting, lacquering, &c., more fully described in the next section, will not be an expensive matter.

The dome and substructure were next inspected. From the brick wall, which rises to a height of about 2 feet, the whole is of iron, the various parts, including the dome, being bolted

[1] Reprinted from the *Cambridge University Reporter*, May 21.

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together in such a way as to render taking down and removal a comparatively easy matter. In addition to the circular inclosure supporting the dome, the height of which is about 20 feet, the dome itself being 40 feet diameter, there are two or three rooms and an entrance porch, available as a dark room and computing room. The mechanism for moving the dome and the dome itself are in good order, but in the opinion of the Committee, it would be advisable to go to some expense in providing brackets for the wheels on which the dome runs with horizontal rollers as guides instead of the flanges on the wheels. The observing platform is a first-rate one and will need no alteration. It is suitable for general observational work, or for work where the use of a large spectroscope renders considerable space necessary in any direction.

The shutters of the dome will require some slight repair.

As regards the apparatus with this telescope there are the usual battery of eye-pieces suitable to the telescope; a series of parallel bar, ring, and other fixed micrometers, a very fine parallel wire micrometer, all complete in mahogany boxes; a fine barrel chronograph in glass case, and a good sidereal clock with compensated pendulum. These with sundry apparatus belonging to the telescope complete the outfit.

We had no opportunity of thoroughly testing the clockwork. We consider that it might be advisable to add an electric control and slow-motion gear of the modern pattern in order to render the telescope more efficient in this respect.

II. We have drawn up a specification showing more fully the work required to be done in order to put the telescope simply into an efficient state, but we would recommend that the opportunity be taken to add electric lighting to the circles and micrometer, to provide an electric control to the clock and an electric slow-motion gear. We would further recommend that 12 cast-iron brackets be added to the dome as supports for the wheels, that one or both of the flanges be turned off these wheels, and that horizontal rollers carried by the brackets be added as guides to keep the wheels on the rail. This, we think, would render the turning of the dome much more easy. We would retain the iron circular wall under the dome in preference to a brick or stone wall, as offering more favourable conditions for the telescope. We have added in the appendix our estimate of the cost of this work.

III. When erected and in working order, this telescope will be specially adapted to any work in observational astronomy for which a large aperture is required, and if it is decided to restrict the use of the telescope to micrometric measures of faint satellites, or to the scrutiny of planetary details, no outlay will be required for additional apparatus, beyond an efficient system of lighting the circles and micrometer with small electric lamps. Should it be determined, however, to undertake work in stellar physics, which we understand, from the letter published in NATURE, is the wish of the donor, and which we would strongly recommend as the most useful systematic work to take up, then the necessary spectroscopic outfit, at present wanting, would have to be provided. We estimate the cost of this at about £100. So equipped the telescope would at once be capable of commencing systematic work of first-class importance that would amply repay the cost of keeping such an instrument regularly employed, and in carrying on such systematic work no further outlay in buildings would be required, the computing and dark rooms attached to the dome being sufficient for the work to be done at the telescope. But in our view it would greatly increase the usefulness of this instrument for spectroscopic research if it were placed within easy reach of a physical laboratory where apparatus would be available for experimental investigations in connection with the telescopic observations. As regards the selection of a site we consider it a matter of great importance that the instrument should be located where it would be easy of access to members of the University engaged in making observations with it. It is essential for the effective use of an instrument in a variable climate that the observer should be as near his work as practicable.

W. H. M. CHRISTIE.
A. AINSLIE COMMON.
April 3, 1889. A. GRAHAM.

The previous experience of these gentlemen has also enabled them to give an approximate estimate of the expense of the removal and re-erection of the telescope at Cambridge. It appears unnecessary to quote the details of their estimate, but the total sum is given by them as £770.

At the time when Mr. Newall had in contemplation his offer to the University, he was already very ill, and the Syndicate heard with deep regret of his death on the 21st of April. They have reason to believe that he was gratified, before his death, with the prospect that his valuable instrument would probably contribute to the advancement of astronomical science at Cambridge.

Since his death, the executors, with the full approval of his family, have renewed the offer to the University. The Syndicate are of opinion that the University should avail itself of the opportunity of possessing this fine instrument, and they are at present occupied with schemes for its proper maintenance and use.

C. E. SEARLE, *Vice-Chancellor.*
E. J. ROUTH.
J. W. L. GLAISHER.
J. C. ADAMS.
G. D. LIVEING.
G. H. DARWIN.
May 18, 1889. J. J. THOMSON.

SOME PROPERTIES OF THE NUMBER 7.

1. MY attention was recently drawn by a pupil to the following property, which will be best illustrated by working out a particular example:

$$\begin{aligned} \text{Let } N &= 342544\,|\,3 \\ u_2 &= 34253\,|\,8 \\ u_3 &= 3423\,|\,7 \\ u_4 &= 340\,|\,9 \\ &\ 32\,|\,2 \\ &\ 2\,|\,8 \end{aligned} \qquad \begin{aligned} i.e.\ u_2 &= 342544 - 2 \times 3 \\ u_3 &= 34253 - 2 \times 8 \\ u_4 &= 3423 - 2 \times 7 \\ &\text{and so on:} \end{aligned}$$

if any one of the quantities u_2, u_3, u_4, &c., is divisible by 7, then N is so divisible.[1]

$$\begin{aligned} \text{For, let } N &= 10P_1 + p_0 \\ u_2 &= 10P_2 + q_1 \\ u_3 &= 10P_3 + q_2 \\ u_4 &= 10P_4 + q_3 \\ u_{n-1} &= 10P_{n-1} + q_{n-2} \\ u_n &= 10P_n + q_{n-1} \qquad = 7Q, \text{ by hypothesis.} \end{aligned}$$

$$\begin{aligned} \text{Now, } 10P_1 &= 10^2P_2 + 10(q_1 + 2p_0) \\ 10^2P_2 &= 10^3P_3 + 10^2(q_2 + 2q_1) \\ 10^3P_3 &= 10^4P_4 + 10^3(q_3 + 2q_2) \\ 10^{n-1}P_{n-1} &= 10^nP_n + 10^{n-1}(q_{n-1} + 2q_{n-2}); \end{aligned}$$

$$\begin{aligned} \therefore N = 10P_1 + p_0 &= 21[p_0 + 10q_1 + \ldots + 10^{n-2}q_{n-2}] \\ &\quad + 10^{n-1}(10P_n + q_{n-1}) \\ &= 21M + 10^{n-1}(7Q) = 7Q^1. \end{aligned}$$

Or we may proceed thus:—

$u_2 = P_1 - 2p_0$; $\therefore N = 10(u_2 + 2p_0) + p_0 = 10u_2 + 21p_0$; hence, if N is divisible by 7, so also is u_2, and so on.

If for 2 we substitute 1, 3, 4, 5, . . . n, then if N is divisible by 11, 31, 41, 51(3, 17), . . . $10n + 1$, so also are (the corresponding) u_2, u_3, . . . u_n.

In like manner, if we strike off 2, 3, . . . n figures, then if N is divisible by (101, 201, . . . $10^2n + 1$), (1001, 2001, . . . $10^3n + 1$), . . . and so on, so are u_2, u_3, . . . u_n.

2. This property was suggested by the question, "Prove that a number consisting of six like figures (111111) is divisible by 7."

Let x be the digit, and let it be repeated n times, then if N be of the form $(7p - nx)10^n + (10^{n-1} + 10^{n-2} + \ldots + 10 + 1)x$, *i.e.* such a number as 5733, in which we have $57 + 2 \times 3$ = multiple of 7, it will be divisible by 7, if $-n \cdot 10^n + (10^n - 1)/9$ is, *i.e.* if $(9n - 1)10^n + 1$ is, *i.e.* if $(2n - 1)10^n + 1$ is, *i.e.* if $(k =)\ (2n - 1)\ 3^n + 1$ is.

Omitting the case of six like digits, we write down the following table for an inferior number, the use of which is explained subsequently.

(1)	(2)	(3)	(4)	(5)
$7p+2\ldots21$	$7p+5\ldots511$	$7p+6\ldots111$	$7p+4\ldots1111$	$7p+1\ldots11111$
$7p+4\ldots42$	$7p+3\ldots322$	$7p+5\ldots222$	$7p+1\ldots2222$	$7p+2\ldots22222$
$7p+6\ldots63$	$7p+1\ldots133$	$7p+4\ldots333$	$7p+5\ldots3333$	$7p+3\ldots33333$
$7p+1\ldots14$	$7p+6\ldots644$	$7p+3\ldots444$	$7p+2\ldots4444$	$7p+4\ldots44444$
$7p+3\ldots35$	$7p+4\ldots455$	$7p+2\ldots555$	$7p+6\ldots5555$	$7p+5\ldots55555$
$7p+5\ldots56$	$7p+2\ldots266$	$7p+1\ldots666$	$7p+3\ldots6666$	$7p+6\ldots66666$

1 In fact, 21 may be substituted for 7.

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